DOCUMENT RESUME

ED 267 656 FL 015 645

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TITLE The Quantitative Study of Communicational Success: Politeness and Accidents in Aviation Discourse.
PUB DATE Dec 85
NOTE 25p.; Paper presented at the Annual Meeting of the Linguistic Society of America (Seattle, WA, December 27-30, 1985).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Accidents; Aviation Technology; Classification; *Communication (Thought Transfer); *Discourse Analysis; *Interpersonal Communication; *Interprofessional Relationship; Power Structure; *Teamwork
IDENTIFIERS *Politeness

ABSTRACT

Part of a larger research program studying communication in the cockpit, this study investigated the occurrence of mitigation, that is, the use of linguistic forms that convey propositional content without giving offense, and its relationship to aviation accidents. The data were from flight-recorder accident transcripts containing observable degradation or failure of crew coordination that was actually or potentially critical to flight completion. Initial analysis of the data suggested several hypotheses concerning the use of mitigation, and quantitative measures were developed and validated. The findings supported the five hypotheses that: (1) requests to superiors are more mitigated; (2) requests are less mitigated in crew-recognized emergencies; (3) requests are less mitigated in crew-recognized problems; (4) topic-failed speech acts (i.e., those not followed up immediately) are more mitigated; and (5) crew suggestions unratified by the captain are more mitigated. A proposed classification of possible contexts for communication, divided according to measures for communicative effectiveness, includes four general contexts (operational, pedagogical, rhetorical, and social/relational) and a number of subcontexts for application in discourse analysis and communicative effectiveness. (MSE)

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THE QUANTITATIVE STUDY OF COMMUNICATIONAL SUCCESS: POLITENESS AND ACCIDENTS IN AVIATION DISCOURSE[1]

Charlotte Linde,
Structural Semantics

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1 Discourse as the Level of Social Action

From its inception, sociolinguistics has never attempted to define itself as a closed, or autonomous discipline. Sociolinguistic studies have always concerned relations between linguistic variables and so-called real world variables such as age, sex, class, etc. Now that techniques for the study of discourse have developed sufficiently, it is possible to go further in studying the relation between linguistic variables and the real world. It is now possible to consider the effectiveness of utterances in their real world context. Such a study of effect, or of communicative success and failure is a crucial direction for the development of linguistics.

Discourse is the level of linguistic structure which can address issues of understanding and improvement of communicative patterns in the so-called real world, because it is primarily at the discourse level that social action takes place. That is, we tend to exchange stories, plans, etc; we do not usually exchange sentences as such, and certainly not morphs or phones.

This claim is not undisputed, of course. [Searle 69, Searle 79] and an entire body of research on speech acts claim that the basic level of social exchange must be viewed as the speech act, which tends to be a single-sentence utterance. However, when one turns from philosophical problems about the necessary and sufficient conditions for successful speech acts to the issue of the actual success or failure of speech acts in the world, we find that the minimum unit of study is not the single speech act but the response pair [Goffman 81]. That is, in order to understand the effect of an utterance, we must also consider the response to it, whether that response is also linguistic, or a nonlinguistic action of compliance or non-compliance.

There is one notable expection to the claim that the discourse level is the most appropriate level for the study of social action: investigations of the relation of the use of Black English to educational success or failure [Labov 67, Labov 83]. In this situation, it is the case that phonological and syntactic patterns can have profound social implications. However, this is an exceptional situation. In general, most studies of the social effects of language have concentrated at the discourse level. There is, for example, a growing body of research on the use of language in legal, medical, educational gatekeeping, and interethnic settings which concentrate at the discourse level. Discourse analysis has great potential for use in the social sciences; see [Quasthoff 85] for an example of interest in narrative analysis from scholars in the fields of sociology and social theory, history, psychology, education, biblical exegesis, aritificial intelligence, and literary theory.

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[1]Please note: in spite of the typography, this is a draft version and I would appreciate comments. Structural Semantics, P.O. Box 707, Palo Alto, CA 94302, (415) 322-8860.

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In order for discourse analysis to address the issue of real-world effectiveness, any study must meet a number of requirements in its choice of data and method of analysis.

1. Real Data. Real situations, rather than invented examples must be used as data. A number of studies in settings such as medicine, law, education, therapy, etc [Frankel 84], [Frankel 85], [Frankel 83], [Griffin & Mehan 81], [Mehan 79], [Sinclair & Coulthard 75], [Tannen & Wallat 83], [West 83], [Gumperz 82], [Erickson 82], have demonstrated that such data is obtainable, and susceptible to analysis. In spite of such demonstrations, there are still complex analyses which are performed on invented or staged data. Such data is questionable for almost any type of analysis, and worthless for the study of communicative success. Note here that we may distinguish between staged and simulated data. Staged data is usually obtained by placing a number of unacquainted graduate students in a room and d requesting them to carry on a conversation, in the absence of either topic or motivation. A simulation, in contrast, includes a physical replica of equipment and normally uses as subjects members of the speech community of interest; further discussion of this point follows. In spite of the difficulties of gaining access to a real subject domain, and becoming familiar with its language and its demands on members, it is an essential part of any analysis of the real world use of language.
2. Sufficient Data. In addition to verisimilitude to the real world, the corpus must be large enough to support quantitative analysis.
3. Quantitative Measures. The study of communicative success must necessarily be quantitative,since no linguistic pattern achieves 100 % success or 100 % failure. Indeed, success or failure of a given linguistic variable normally requires a fairly extensive investigation. We are still in the process of discovering the appropriate quantitative measures for discourse level data, since to date, there have been few quantitative studies at the discourse level. ([Chafe 80] does demonstrate the use of some simple statistical measures. See sections 4 and 5 for a demonstration of the use of quantitative measures on aviation discourse.)

2 Overview of the Research

This paper describes research on the use of mitigation and its effects in a vital real-world context: air crew communication in emergency and accident situations. For some time mitigation has been understood to be an important factor in communication [Labov & Fanshel 77]. However, there have been few detailed empirical studies of the actual operation and effects of mitigation in adult speech. (The one exception is [Ervin-Tripp 76].)

The study of mitigation discussed in this paper forms part of a larger research program studying communication in the cockpit.[2] The purpose of this research is to reduce the incidence of those aviation accidents caused wholly or in part by problems in crew communication and coordination, that is, accidents in which equipment failure is not the primary cause. One way

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[2]This research is sponsored by the National Aeronautics and Space Agency, Ames Research Center; see [Structural Semantics 83] for a full report of the research. The linguistic study of simulator data discussed below is part of a larger NASA project studying crew communication and coordination; see [Murphy *et al.* 84] for an overview of the project.

to do this is to train crews to communicate more effectively. Therefore, it is necessary to discover which communication patterns are actually most effective in specific situations. Such studies are also intended to be useful in developing linguistic measures for assessing other aspects of crew performance, such as attention, fatigue, etc, and to provide guidelines for the design of aviation procedures and equipment, for example new technology permitting computer-generated verbal communication.

2.1 Data of the Study

There are several types of data which a study of air crew communication might use. The study reported in this paper uses as data transcripts of eight aviation accidents, the so-called black box transcripts. The black box contains an audio recorder with a 30 minute tape loop, which is automatically erased in the case of a successful flight. The value of such data, of course, is its intrinsic interest and its naturalness. Although crew members know that they are being taped, such taping is a normal part of every flight, and the presence of the recorder does not alter their behavior. This data has, however, three restrictions. The first is that any investigation is restricted to those situations which develop in 30 minutes or less. The second is that because the tapes of successful flights are erased, there are examples only of failed flights, and so it is not possible to study successful crew communication in problem situations. Finally, because of legal complications, at present only the transcripts of these tapes are available. Because the tapes themselves can not be used, investigations must be restricted to questions which do not require phonological information. In spite of these restrictions, the data is still extremely valuable for a wide range of investigations.

It is also possible to supplement the black box data by the use of data from flight simulator experiments. An ongoing investigation is using as data audio and video recordings of 16 crews in a full mission simulator, each run through the same scenario. This study provides data on both successful and unsuccessful flights, with full audio, video, and systems data. The restriction on such data is that we do not know how closely a simulator session reproduces actual crew communications in a real flight. However, comparison of accident data in real flight and simulated flight may permit us to determine this.

In the current study of accident transcripts, we applied the following criteria to a group of 11 transcripts selected by NASA personnel as potentially suitable for investigation, and chose 8 as suitable.[3]

1. The transcript contain must a critical segment. A **critical segment** is a portion of transcript containing observable degradation or failure of crew coordination which is actually or potentially critical to the completion of the flight.
2. The entire stuation of interest must not be significantly longer than 30 minutes (since the maximum length of the tape is 30 minutes).
3. There must be sufficient background information to permit understanding all relevant aspects of the situation.

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[3]The 8 accidents are: United Airlines/Portland/78; Eastern Airlines/Miami/72; Northwest Orient Airlines/Thiells, N.Y./74; Allegheny Airlines/Rochester/78; World Airlines/Cold Bay, Alaska/73; Texas International Airlines/Mena, Arkansas/73; Pan American Airlines/ Bali/74; Air Florida/ Washington D.C./82.

4. The language of the transcript should be suitable for analysis. This means that there should be enough talk to permit analysis, and that all the conversation should be in English, since this study does not focus on cross-linguistic problems.
5. There should be sufficient interest and agreement in the aviation community to support further investigation.
6. All other things being equal, more recent transcripts are preferred. (Note that this criterion plays a major role in determining whether or not criterion 5 is satisfied; older flights are of lesser interest since the procedures and equipment are more likely to have been superseded.)
7. If possible, the set of transcripts should include all flight segments -- taxi, takeoff, climb, cruise, approach and land.

3 Theory of Mitigation

Having established the nature of the data, we may now turn to the issue of mitigation. The basic intuition about mitigation is that, while some sentences are quite direct, other sentences with the same (or similar) social force are more indirect. Furthermore, these differences in degree of directness correspond to differences in degree of politeness. Thus, most native speakers of English feel that (1) is quite direct, while (2) is quite indirect, and also more polite.

(1) CAM-1 **Reset that circuit breaker momentarily, see if we get gear lights** (1810:17)

(2) CAM-1 **Do you want to run through the approach descent yourself? So you don't forget something** (1754:18)

A **mitigated** form is one which expresses a given propositional content in such a way as to avoid giving offense. An **aggravated** form, such as (3), has more potential for giving offense.

(3) CAM-2 **Get this # on the ground** (1801:45)

As many analysts have noted, aggravation is considerably rarer than mitigation in most social situations, and there are far more forms for mitigation than for aggravation [Labov & Fanshel 77]. Therefore, the following discussion focusses on mitigation.

3.1 Theory of Mitigation

There are many linguistic devices which function as mitigations: questions are more mitigating than imperatives; modal auxiliaries, such as **would**, **might** and **could**, are more mitigating than simple verbs; markers of request for agreement, such as **right** and **OK**, are mitigating. This list could be continued almost indefinitely. However, in order to deal with all the mitigation devices and strategies ocurring in a given text, it would be preferrable to have some theory of why such a seemingly heterogenous group of linguistic phenomena should serve this function.

Such a theory has been given by [Brown and Levinson 79].[4]

Brown and Levinson's account is based on the notion that politeness is the attempt to avoid **face threatening action**, where **face** is the public self-image that every member of the culture wants to claim for himself/herself [Goffman 67]. There are two types of face, negative and positive. **Negative face** is "the basic claim to territories, personal reserves, rights to non-distraction -- i.e. to freedom of action and freedom from imposition." **Postive face** is the "positive consistant self-image or 'personality' (crucially including the desire that this self-image be appreciated and approved of) claimed by interactants" ([Brown and Levinson 79] p. 66.) These two types of face give rise to two types of politeness, also called negative and positive. **Negative politeness** attempts to minimize the degree of trespass to the addressee's autonomy; **positive politeness** attempts to minimize the distance between speaker and addressee, so that the speaker's and addressee's desires appear to be the same.

Brown and Levinson also identify a third class of strategies for politeness, called **off record** strategies. These are modes of indirection which permit the speaker to avoid being held accountable for what he/she intends to convey. Such strategies include hints, irony, under- and overstatement, and in general, have an aspect of langauge play. Given the serious nature of these situations, they are fairly rare in this data. This is fortunate, since they are particularly likely to be misinterpreted. No further discussion of off record strategies is necessary for the present study.

Figures 1 and 2 show examples of negative and positive strategies for orders and suggestions in this data. Although these are not the only speech acts that can be mitigated, they are among the most likely to be mitigated, since a request that someone do something, following Brown and Levinson, is a threat to the adressee's autonomy. However, it should be noted that in the cockpit situation, where there is a strict and known hierarchy of command, a request for action is less face threatening than would be the case in a more egalitarian or undefined social situation.

As these figures show, both negative and positive politeness strategies are found in this data. Negative politeness, in Brown and Levinson's system, corresponds to what we have called mitigation. Examples of positive politeness are found, but are generally judged by members of the aviation community to be direct, rather than polite. This may be because the basis of these strategies is to create solidarity, or minimize difference between interlocutors. It appears that the solidarity of an aviation crew is already sufficiently strong that no additional closeness can be created by linguistic strategies, at least of this nature.[5]

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[4] A similar theory of politeness has been developed by R. Lakoff in a series of papers; Brown and Levinson's work is used here because of the convenience of their single unified presentation.

[5] If this is true, it is particularly interesting since the solidarity present for an aviation crew is the result of the work situation, not of personal relations. That is, commercial aviation crews are not normally kept together; for any given flight, the crew members may never have met one another before. The solidarity of such a situation is thus a product of role relations rather than personal relations.

- Give Reason for Request
  Do you want to run through the approach descent yourself? So you don't forget something.
  1 --> 3 (1752:20)

- Give Options about Compliance

- Frame Request as Suggestion
  If I might make a suggestion -- you should put your coats on.
  4 --> 1,2,3 (1748:21)

- Frame Order as Request
  Why don't you put all your books in your bag over there Rod.
  1 --> 2 (1755:55)

- Minimize Extent of Action Required
  Do you have the signal for not evacuate, also the signal for protective position. That's the only things I need from you right now.
  6 --> 1 (1744:40)

- Make Request Hypothetical
  If I might make a suggestion, you should put your coats on.
  4 --> 1,2,3 (1748:21)

- Use Modal Auxiliary
  If I might make a suggestion, you should put your coats on.
  4 --> 1,2,3 (1748:21)

- Use If Clause
  If I might make a suggestion, you should put your coats on.
  4 --> 1,2,3 (1748:21)

The device of interest is indicated by underlines. Speaker and addressee are denoted by numerals; for example 1 --> 3 is spoken by the captain to the flight engineer.

Figure 1: Examples of Negative Politness Strategies

4 The Quantification of Mitigation

Our study of mitigation in this data suggests a number of hypotheses about its effect on the success or failure of communications. However, in order to test them, we need not just a definition of the phenomenon of mitigation and aggravation, but also require the discrimination

- Minimize Distance Between Speaker and Addressee

- Use Informal Syntax

  How much fuel we got, Frostie?

  1 --> 3 (1746:52)

- Use Informal Lexical Choice

  But if anything goes wrong, you just charge back and get your ass off, OK.

  1 --> 4 (1748:40)

- Use us Rather than me

  Yeah give us three or four thousand pounds on top of zero fuel weight.

  1 --> 3 (1750:30)

- Seek Agreement

  You're going to take care of the shutdown, right.

  2 --> 1 (?) (1758:18)

The device of interest is indicated by underlines. Speaker and addressee are denoted by numerals; for example 1 --> 3 is spoken by the captain to the flight engineer.

Figure 2: Examples of Positive Politness Strategies

of degrees in a scale of mitigation and aggravation. The degrees of this scale correspond to the sense felt by the native speakers of a language that some sentences are more polite or more indirect than others. It would be desirable to have a theory of mitigation which would allow the computation of the degree of mitigation of an utterance precisely, counting for example, .2 for "please," .6 for a modal form, etc. Since no such theory of mitigation exists, of course, it was necessary to establish a scale of degrees of mitigation using the judgments of several linguistic analysts. The validity of this scale was established by checking these judgements against the judgements of members of the aviation community.

We have found that four degrees of mitigation/aggravation are the most that native speakers can reliably discriminate. This scale has a midpoint of zero, representing a direct, unmitigated utterance. There are two degrees of mitigation -- low and high. There is only one degree of aggravation, corresponding to the facts that aggravation is much rarer than mitigation [Labov & Fanshel 77], and that there are fewer strategies for effecting aggravation than for effecting mitigation.[6]

[6]We had originally attempted to score examples on a six point scale -- High Aggravated, Low Aggravated, Direct, Low Mitigated, High Mitigated -- but this was not reliable, even for the judgements of the analysts.

In choosing examples for the test, we attempted to avoid speech acts which involved ambiguous social force or contradictory mitigation strategies. However, ten such "bad" sentences were also included in the sample, even though we did not intend to use them in the evaluation process, in order to check the assumption that this kind of sentence would pose special difficulties. (We found that in fact they did.) The use of indirect speech acts for mitigation is extremely complex, and requires a great deal of context to interpret, more than could feasibly be included in such a test.

To give an example of the sentences used, the following are the sentences used in the pre-test training.

DIRECT

a. Captain to Flight Engineer: **Give us a current card on weight figure in about another fifteen minutes**
b. Captain to Flight Engineer: **how much fuel we got, Frostie?**
c. Copilot to Captain: **Are you going to do a procedure turn, John**
d. Copilot to Captain: **The visibility is dropping**

LOW MITIGATION

a. Captain to Flight Engineer: **About time you give that brace position**
b. Copilot to Captain: **Let's take the shortest route to the airport**
c. Flight Engineer to Captain: **[Reporting on landing gear] Both of them appear to be down and locked.**
d. Captain to Copilot: **I'd slow it up a little bit too**

HIGH MITIGATION

a. Off-duty Captain to Captain: **[Discussing possible emergency landing] If I might make a suggestion -- you should put your coats on -- both for your protection and so you'll be noticed so they'll know who you are**
b. Copilot to Captain: **Do you have any idea of what the frequency of the Paris VOR is?**

AGGRAVATED

a. Captain to Flight Engineer: **[Discussing possible emergency landing] You just haul ass back there and do whatever needs doing**
b. Captain to Flight Engineer: **[Discussing engine crossfeeds after loosing one engine] Open em both # get some fuel in there**

The experiment used as subjects six commercial airline professionals, including two of the rank of captain, three of the rank of first officer, and one of the rank of flight engineer. Before being asked to rank the speech acts, they were given the following pre-test training in the meaning of the categories used: A previously prepared explanation of the notion of mitigation was read to the subjects. They were then given some sample written examples to rate, and these examples were discussed by one of the analysts with the group. Finally, they were given the written speech act protocols to score.

An analysis was made of the match between the subjects' mitigation ratings and those of the analysts. The criterion which is generally used for reliability of such scales is a stringent one: there should be at least an 80% match between the subjects and the analysts; that is, the average number of agreements of the analysts' judgements with the subjects' exceed 8 out of 10. This criterion was just met in the present experiment, in which the average agreement of the six subjects with the analysts' judgement was .801. Although neither the number of subjects nor the number of stimuli were as great as originally planned, they are sufficient to support concluding that this is indeed a reliable scale for degrees of mitigation, and therefore that mitigation is a variable which can be used in formulating hypotheses.

An interesting factor affecting subject variance in coding is regional dialect differences. To my knowledge, there has been no research on regional differences in the use of mitigation. This study suggests that such an investigation could be quite fruitful. While data from six subjects can only be regarded as suggestive for this purpose, the following facts should be noted: there were two subjects each from California, New York State, and the South; the analysts are from the North-East (one from New York City and one from Western Massachusetts). The inter-subject agreement for New York subjects is higher than that for California subjects or Southern subjects (.81 versus .71 for Califonia and .68 for Southern subjects). The average agreement of the New York subjects with the analysts is higher than with any other region (.90 versus .76 for California and .71 for Southern). These figures suggest that further experimentation would be valuable, in order to determine whether regional dialect differences in aircrew composition could be a significant factor in speech act misinterpretations that could potentially lead to accidents. This would be a significant finding, because it would be possible to train crew members to recognize the intended mitigation values of speakers from other regions. In fact, during the pretest period, subjects joked with one another about their regional mitigation peculiarities.

In addition to regional differences, there were also systematic differences between the analysts and the aviation community members which point to the existence of speech act idioms, or more geneally, rhetorical conventions peculiar to this community. The clearest example is the case of indirect requests which make reference to wants. Some examples of this type are:

(6) 1 -> 3 Want to wake everybody up and get 'em in here please

(7) 2 -> 1 Do you want to run everything but the flaps

(8) 2 -> 1 You want me to fly it Bob?

The members of the aviation community treated these as less mitigated than the analysts did. It appears that this strategy has become so conventionalized that its social force direct, even though its form is indirect, and hence mitigated.

The use of this technique to validate the scale of mitigation, is particularly interesting, since it can be viewed as the meeting, and we hope, marriage, of statistical methodology with ethnomethodology. As mentioned in section 4, the experimental validation of the scale of mitigation was devised because there is no current theory of mitigation which permis one to compute the degree of mitigation of a given sentence. This means that the assignment of the degree of mitigation of a sentence must be done by the intuition of the analyst. This is a familiar enough situation, particularly in psychology, and is normally handled by coder reliability studies. However, having determined that inter-coder reliability was acceptable, there remains the question of whether the intuitions of the coders matched those of the aviation community whose communication we wish to understand. Although we as analysts have native speakers' competence in English, we do not have members' knowledge of the rhetorical conventions of the aviation speech community.[7] Therefore, it was necessary to ascertain that our assignment of mitigation values in fact agreed with those of members of this community, after training in the notion of mitigation. In fact, this particular piece of methodological precision is an attempt to be serious about members' competence within community of interest, that is, an attempt to be certain that we as analysts are not imposing a category system on the data which has no relation to the category system of the members themselves.

5 Results

We turn now to the hypotheses on the effects of mitigation on the success of communication. All of these hypotheses have been verified.

5.1 Requests to Superiors Are More Mitigated

This hypothesis represents a test of the intuition that the speech of subordinates is more tentative and indirect than the speech of superiors. It is important because it shows a direct effect of the basic social hierarchy on cockpit discourse. In connection with hypotheses 4 and 5, it suggests that certain types of communications by subordinates are likely to fail. Thoeretically, it suggests studies of the relation of mitigation and social rank in other contexts. Practically, it suggests that it would be worth to use less mitigation would improve crew performance. (Such a training hypothesis can not itself be tested with data from accident transcripts, but could be tested with simulator experiment data.)

5.2 Requests Are Less Mitigated in Crew Recognized Emergencies

We define a Crew Recognized Emergency (CRE) as a condition in which the entire crew attends to the situation which led directly to the accident. This hypothesis reflects the intuition

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[7] For a lively and quite accurate description of these rhetorical conventions, see [Wolfe 79].

that when crew members know that they face an emergency situation, their speech is less tentative and indirect. As is well known, in any utterance, the speaker is encoding both his understanding of the situation he is talking about (the referential aspect) and his understanding of the relation between himself and his addressee. Mitigation level is a major linguistic means by which a speaker can indicate his understanding of this social relation. When the situation becomes urgent, we might expect the speaker to focus more of his attention on it, and thus less attention upon social relations. Note, however, that although mitigation decreases in Crew Recognized Emergencies (and Crew Recognized Problems, as discussed below), it never disappears entirely, no matter how serious the situation.

5.3 Requests are Less Mitigated in Crew Recognized Problems

We define a Crew Recognized Problem (CRP) as a situation recognized by the crew to be potentially dangerous and not a normal part of flight operations. This hypothesis corresponds to the intuition that crew members' speech is less tentative and indirect when they know they face a problem. Its significance is similar to that of the previous hypothesis. (Note that every CRE speech act is also a CRP speech act.)

5.4 Topic Failed Speech Acts Are More Mitigated

This hypothesis and the next one are direct tests of whether excessive mitigation has undesirable effects in the cockpit. Hypothesis 4 represents the intuition that a new topic is less likely to be continued by its addressees if the speech act in which it is introduced is excessively mitigated. We count as topic failed any speech acts expressing a new topic not followed by a speech act having the same topic from another speaker. Note that this definition counts as successful a case in which a topic is mentioned and its addressee verbally refuses to consider it. This is deliberate. We are most concerned whtih cases in which an attempt to introduce a topic receives no attention from the rest of the crew. In the case of a verbal refusal, there is at least evidence that the topic has been attended to and considered, even if its relevance is finally denied.

Acceptance of this hypothesis lends strong support to the intuition that excessive mitigation can have undesirable effects on crew performance. A number of Nathional Transportation Safety Board reports have recommended assertiveness training for crew members to encourage effective participation by subordinates. Verification of the present hypothesis and the following one, demonstrate effects for one kind of lack of assertiveness. Moreover, this kind of lack of assertiveness is defined precisely enough to allow for both training and for the evaluation of training methods.

5.5 Unratified Draft Orders Are More Mitigated

This hypothesis attempts to test the intuition that when a crew member proposes a suggestion to the captain, the more indirect and tentative that suggestion is, the less likely the captain is to ratify it. Like hypothesis 4, this hypothesis implies that excessive mitigation can have undesirable effects on crew performance. In particular, this hypothesis focusses attention on the

situation in which a subordinate makes a correct suggestion which is ignored.[8] Training in linguistic directness should be valuable in correcting this kind of pattern.

5.6 Summary of Results

Figure 3 shows for each hypothesis: the size, N, of the dataset used to test it; the obtained t value (if any); the obtained χ^2 value; the number of degrees of freedom (for the χ^2 test); the obtained probability level for the t test; the obtained probability level for the χ^2 test; and the decision (whether or not the research hypothesis was accepted). The decisions obtained using the χ^2 test agree with those obtained using the t test, except in the case of Hypothesis 1. Although the χ^2 value is very close to that required for acceptance, a reader who is doubtful about the applicability of the t test, may want to consider this hypothesis rejected.

Hypothesis	N	t	χ^2	df	P_t	P_χ	Decision
1	254	2.01	7.45	3	.022	.05+	Yes
2	278	3.46	12.81	3	.0003	<.01	Yes
3	278	1.79	4.70	3	.047	<.01	Yes
4	266	2.49	7.95	3	.0064	<.05	Yes
5	62	2.41	9.52	3	.008	.02+	Yes

Figure 3: Summary of Results

6 The Study of Communicative Effectiveness

THere have been a number of theoretical and methodological developments reported in this paper. However, perhaps the most important is the serious consideration of the issue of interactional success or failure. This project uses a statistical verification of the interactional effects of specific linguistic patterns. This is an extremely important development in the scope of discourse analysis. Traditionally in linguistic studies, the primary question about any utterance is whether it is well formed or not, and why. However, this is not an adequate question for studies of phenomena at the discourse level; here, we must also ask whether a given utterance has succeeded, and why. In order to answer such questions, it is necessary to have a definition of interactional success, and a methodology for determining it.

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[8] Note that hypotheses 4 and 5 show a correlation between a linguistic pattern and its interactional success or failure. They do not show a direct causal effect of the linguistic pattern on the failure of the flight.

There have been a number of attempts to define interactional success, some of which are promising, and others of which are methodologically flawed. The most commonly used approach is the speech act approach, which uses the linguistic form of a single speech act to determine the illocutionary force of the speech act, that is, the effect it would have if it were successful. The illocuionary force represents the speaker's intention, what he/she wishes to accomplish with the utterance.

There are several reasons why this account of the success of speech acts is insufficient. One is that there is no reliable way of ascertaining the intention of a speaker, or any other such postulated mental entity. Speech act theory relies on the judgment of the analyst in making this determination. This is a feasible move in cases where the example sentences have been constructed by the analyst, and represent relatively simple cases. But in the more complex cases which occur in actual transcripts, analysts differ in their interpretations, and a definitive interpretation can not be determined in this way.

A second problem is that this method considers only the possible effect of a particular speech act. Thus, it permits us to determine whether a particular speech act, for example, a promise has been made, but does not extend to determining whether that promise actually is carried out. The actual carrying out of a speech act in the world is termed, within speech act theory, its **perlocutionary force**, and all writers on speech act theory have deemed it beyond the scope of the theory's consideration.

There have also been a number of empirical approaches to the study of the effect of linguistic patterns on communicative success.

1. **Attempts to retrieve the intention of the speaker.**

A number of studies have attempted to work back to the intention of the speaker by playing back the discourse to the speakers involved and requesting their interpretation of it. [Erickson 82], [Tannen 79]. The value of this method entirely depends on the claims made for the speakers' interpretations. The strongest possible claim would be that the speaker's interpretation actually represents his intention at the time of speaking. Such a claim is entirely too strong. Even when the speaker can be asked about his intention (which is rarely true in the case of an aviation accident discourse), his memory of an intention is not fully reliable, and can not be given privileged status. In fact, his account of his intention is more data to be analyzed, and data of a more complex type than a direct transcription of a naturally occurring conversation.

For example, consider the following case from the aviation accident domain, Allegheny Airlines/Rochester/78. The facts are that the accident resulted from the pilot landing at too high a speed, choosing to land when he could safely have executed a go-around and made a second attempt. Since crew and passengers all survived the crash, the National Transportation Safety Board was able to question the crew members on the reasons for their actions. They asked the copilot why he did not advise the captain to do a go-around. He claimed that he did warn him, pointing out in the transcription of the black box tape his utterance "Oh, Jack"

which he claimed should actually have been transcribed as "Go, Jack," and should be interpreted as a suggestion for a go-around. In a situation like this, it is impossible to make a principled decision on which shall be given priority: the speaker's account of his intentions, the transcript, the tape, etc.

2. **Attempts to use the speaker as a representative member of a class**

A more cautious use of speakers' interpretation is also possible, and leads to much solider results. [Frankel & Beckman 82] shows videotapes of a doctor -- patient consultation to the participants, and requests them to indicate points at which they feel that problems have arisen. In this case, the participants are used not because they uniquely possess memories of their intentions in the situation, but because they are appropriate members of the class of doctors and patients. This interpretation is underscored by also having the scene viewed by other doctors and experienced medical educators.

3. **Attempts to Use Internal Evidence in the Text**

Another empirical approach to the study of the success of utterances is to use internal textual evidence, bypassing entirely the issue of speakers' intentions. Such evidence can include unusually long pauses, rhythmic asynchrony, direct markers of particpant incomprehension, up to complete breakdown of the interaction. Examples of such studies include [Gumperz 82], [Scollon&Scollon 81], [Erickson 82], [McDermott 76]. Studies of this nature can be of great value; their application appears to be most appropriate in cross-cultural (or sub-cultural) studies, where the possibilities for communication breakdown are most massive.

4. **Attempts to use native speaker's intuition to judge native -- nonnative communication.** Studies of this type are based on a judgement of the match between what a nonnative speaker said, and what he must have intended, based on the judgement of a native speaker analyst. Such studies assume the ability of the native speaker to reconstruct the communicative intention of the nonnative speaker. This strategy in theory is subject to the same criticism of the use of intention as speech act theory. In practice, the examples are frequently so obvious that the judgments appear to be defensible [Varonis&Gass 85].

In the study of interactional success or failure, aviation accident data is a uniquely valuable research site, both because we have the strongest of external evidence that the overall speech situation has failed, and because the Cockpit Voice Recorder transcripts, taken together with the NTSB reports, provide a context that contains a wide range of information about the actual effects of speech acts. Such data permits a number of empirical methods for determining the success or failure of utterances.

The simplest measure of success, which is used in the present study, is to determine the effect of a given speech act by examining later utterances and aviation systems data. This partially corresponds to Method 3 discussed above. For example, if we are interested in whether a suggestion by a subordinate was accepted, we can try to judge if the captain accepted or rejected it, based on what he said, or what was done with the airplane. If we are concerned

about whether the proposal of a new topic succeeds, we can check whether the utterances immediately following this topic continue it. This is possible because the transcripts of the entire interaction are available, as well as ome tyupes of systems data. It is also possible because we are concerned not with the speakers' and addressees' beliefs, intentions, etc, but only with their actions. Thus, with a speech act of persuading, we are concerned not with whether the addressee actually feels convinced, but only with whether he acts as though he were convinced. (This is presumeably the case for most speech act theoretic accounts as weli; the problem arises because a constructed example can not exhibit speakers subsequent behavior.)

The methods described above rely crucially on the fact that we have data on the entire interaction, and so are able to consult later utterances to determine the effect of an earlier one. They also rely implicitly on the fact that we know that these are the records of aviation accidents; we have the strongest possible non-linguistic evidence to suggest that these are unsuccessful interactions. In later studies of simulator data, it should also be possible to make finer-grained correlations between linguistic patterns and the operational situation.

Further refinement of the study of communicative success or failure is possible using the full mission scenarios already discussed, since these permit more delicate discriminations of mission success than simply whether the flight ended in a crash or not. Using videotapes of these session, it is possible to obtain judgements from aviation professionals on a range of measures of success, for segments of any length. For example, experienced training pilots were asked to rate crews for such variables as safety performance, decision efficiency, decision quality, crew cohesiveness, crew friendliness, crew coordination, communcation quality, etc [Murphy&Awe 85]. This data is currrently being related to linguistic variables to refine our study of communicative effectiveness.

7 Operational Classification of Communication Types

This paper has shown that the study of communicative effectiveness is a possible and necessary direction for discourse analysis. Using data from commercial aviation accidents, it has demonstrated the isolation of linguistic variables which can be correlated with measures of linguistic success and failure. It has also suggested further measures which can be applied to such data. It is now necessary to ask whether these methods and these measures are generally applicable, and if they are not, what conditions restrict their application.

To answer this question, we need a classification of possible contexts, divided according to the measures appropriate for measuring communicative effectiveness. Although there is a twenty five hundred year old tradition of rhetoric in the West which studies and classifies types of text, non of these systems are organized operationally, in terms of the methods required to study the various types. THe following is a suggested operational classification.

7.1 Operational Contexts

Operational contexts are social situations in which language is used directly to accomplish specifiable goals in the world. These may be further divided into situations in which language is an adjunct to physical action, and those in which language is an intrinsic part of social action.

1. Language as an Adjunct to Physical Action. In these cases, the organization of the language use is not autonomous, but rather is driven by the physical action system which it accompanies. The aviation context discussed in this paper is one such case. See also [Goffman 81] for a discussion of the issues raised by this type of context.
2. Language as a Component of Social Action. In these contexts, language is used either partially or wholly to effect specifiable social actions which whose accomplishment is not primarily physical. Examples of this type of language use include political planning [Linde & Goguen 78] and legal plea bargaining [Maynard 85].

In both types, the effect of a particular utterance can be observed in the subsequentphysical or social situation. The shorter and more bounded the situation, the easier it is to study.

7.2 Pedagogical Contexts

Pedagogical contexts are situations in which language is used to effect a change in the cognitive organization of some of the participants. A pedagogical communication has been a success when the students have actually learned what the teacher is trying to teach. A continuing question in education and educational psychology is the appropriate methods for measuring whether this has taken place.

7.3 Rhetorical Contexts

Rhetorical contexts are those in which the form of the language used is a major focus of attention. Two types can be distinguished: rhetoric which is primarily persuasive, and rhetoric which is primarily artistic.

1. Persuasive Rhetoric. These are situation in which language is used to change its addressees' opinion on some issue. In some cases, like advertising or campaign speeches, it may be possible to observe the addressees' actions and from them, devise a measure of the effectiveness of the communication. In many persuasive contexts, such as sermons and political addresses, no such simple relation can be established, since no single type of action is specified.
2. Self Presentational Rhetoric. This may be considered as a form of persuasive rhetoric, in which language is used to present an image or story about the self claimed by the speaker. Narratives comprising life stories, and other types of self presentation are examples [Linde 84, Quasthoff 86, Linde 86, Frank 81, Frank 84]. Success in these contexts is difficult to measure. Rough measures would include addressees' acceptance of of the self-presentation, and the degree of personal satisfaction or distress which a given self-presentation affords the speaker.
3. Artistic Rhetoric. These are situations in which language is used for for its own sake, or for the pleasure of the participants. Traditional literary studies discuss effectiveness in

these areas; the measure of effectiveness has been the judgement of trained experts. Studies in the ethonography of speaking which investigate oral art forms rely on judgements by members of the speech community on the success of a given attempt [Abrahams 72], [Labov 72].

7.4 Social/Relational Contexts

These are situations in which language is used primarily to facilitate a social relation. Chat, small-talk, gossip etc. are common terms for this type of context. Here the success of the communication can be studied by measuring the long-term course of the relationship.

7.5 Conclusion

This classification is not intended to be comprehensive. Rather, it presents major types of communication which have been studied, and their associated measures of communicative effectiveness. It is clear that this is an area which merits further study, since fuller understanding of communicative effectiveness can greatly extend the possible scope and value of linguistics. The present study is intended as a model for such research.

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Table of Contents

1 Discourse as the Level of Social Action 1
2 Overview of the Research 2
2.1 Data of the Study 3
3 Theory of Mitigation 4
3.1 Theory of Mitigation 4
4 The Quantification of Mitigation 6
5 Results 10
5.1 Requests to Superiors Are More Mitigated 10
5.2 Requests Are Less Mitigated in Crew Recognized Emergencies 10
5.3 Requests are Less Mitigated in Crew Recognized Problems 11
5.4 Topic Failed Speech Acts Are More Mitigated 11
5.5 Unratified Draft Orders Are More Mitigated 11
5.6 Summary of Results 12
6 The Study of Communicative Effectivenss 12
7 Operational Classification of Communication Types 15
7.1 Operational Contexts 16
7.2 Pedagogical Contexts 16
7.3 Rhetorical Contexts 16
7.4 Social/Relational Contexts 17
7.5 Conclusion 17

List of Figures

Figure 1: Examples of Negative Politness Strategies 6
Figure 2: Examples of Positive Politness Strategies 7
Figure 3: Summary of Results 12